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# NITRITE OF AMYL

AS AN

## ANTIDOTE TO CHLOROFORM.

✓  
BY

F. A. BURRALL, A. M., M. D.,

FELLOW OF THE NEW YORK ACADEMY OF MEDICINE.



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## NITRITE OF AMYL AS AN ANTIDOTE TO CHLOROFORM.<sup>1</sup>

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THE prompt action of chloroform and the calm sleep which it induces, its comparatively pleasant taste, and the usual absence of subsequent vomiting, would alone be sufficient to secure its general adoption as an anæsthetic, were it not that so many physicians regard it as uncertain and dangerous. With some, this conviction is so decided that they advocate its entire disuse as the only radical method of avoiding the attendant risks. Others restrict its employment to certain classes of patients in which they consider dangerous results as unlikely to occur.

The medical journals still continue to report a noticeable number of fatal cases, and these are occasionally collated with comments by medical writers. If the number of deaths be diminishing, a point rather difficult to decide, it must be remembered that, as has been previously observed, very many physicians have discarded it as an anæsthetic. According to one statement<sup>2</sup> a death occurs in every 2,723 administrations, while a more recent writer gives the proportion as one death in 2,500 patients.<sup>3</sup> Clinical observation seems to teach that the fatal cases are usually those of syncope or cardiac

<sup>1</sup> Read before the Academy, September 21, 1876.

<sup>2</sup> *Chicago Medical Examiner*, 1870.

<sup>3</sup> *London Lancet*, August 7, 1875. A communication from Dr. Brudenell Carter.

paralysis;<sup>1</sup> sometimes respiration ceases primarily;<sup>2</sup> and occasionally the pulse and respiration come to an almost simultaneous stop.<sup>3</sup>

The danger of grave consequences is less under certain circumstances, and in certain classes of patients, than in others. The records of the lying-in chamber show few, if any, well-authenticated fatal cases, although individual practitioners will narrate instances in their own practice where deadly symptoms seemed so imminent as to deter them from a future use of this anæsthetic. Yet, when it is considered how frequently chloroform is used in obstetric practice, and administered by unskilled friends or nurses, without bad consequences, it must be regarded as an agent which involves here less than its usual risks.

Perhaps the great struggles of the system during labor tend to sustain *reflex action*, and, by averting the destruction of one of those functions which chloroform destroys, diminish its risks. Some hold that the great muscular activity which occurs at that time maintains the circulation, and prevents the cerebral anæmia<sup>4</sup> which chloroform tends to induce.

There is also a favorable testimony as to its employment in military practice. Says Surgeon George A. Otis, in Circular No. 6, issued from the Surgeon-General's Office in 1865: "The returns indicate that chloroform was administered to not less than eighty thousand cases. In *seven* instances fatal results have been ascribed with apparent fairness to its use." Again, there is good authority for preferring it to ether in the case

<sup>1</sup> "One surgeon in London asserts that he has seen sixteen deaths, and another six. The deadly cases are those of syncope or paralysis of the heart, and this, whenever it occurs, appears to place the victim beyond the reach of human aid."—(London *Lancet*, August 7, 1875. A communication from Dr. Brudenell Carter.)

<sup>2</sup> As to one of the modes of death, *see* a paper by Dr. A. H. Smith, of New York, in the "Transactions of the New York State Medical Society" for 1871, p. 226.

<sup>3</sup> *See Pacific Medical and Surgical Journal*, July, 1869, p. 92. *American Journal of Medical Sciences*, 1867. *Medical News and Library*, December, 1869. "Transactions of the New Hampshire State Medical Society," 1869.

<sup>4</sup> "Half-Yearly Compendium of Medical Sciences," July, 1876, p. 176.

of children, although this must be regarded as doubtful, while it is very certain that it should not be employed for operative procedures of a trifling character, since the mortality under such circumstances has been relatively large.

Those whose unfavorable opinion of chloroform is derived mainly from impressions, rather than a study of facts, will find their impressions strengthened by the conclusions of Prof. Schiff, which are based on five thousand experiments performed by himself. This eminent physiologist has expressed himself adversely to chloroform, in a communication recently made to the Società Medico-fisica of Florence. He believes that both anæsthetics produce paralysis of conscious sensation, voluntary muscular movement, respiration, circulation, and finally of the heart and vaso-motor nerves. With ether, respiratory precedes vascular paralysis, and the vascular pressure remains sufficiently high to afford an opportunity of restoring animation if artificial respiration is resorted to immediately after natural respiration has ceased. With chloroform, however, vascular paralysis frequently precedes respiratory, and an amount of chloroform insufficient to cause paralysis of respiration will often produce vascular paralysis, accompanied by such a diminution of blood-pressure as to render artificial respiration useless, since interchange between the gases of the air and blood does not take place. Here, artificial respiration does not recall life, and respiration ceases when artificial aid is removed.

An opinion like this from an eminent observer, and based on experiment, cannot but carry much weight; yet physicians rely on their individual experience. This experience differs something as follows: One has used chloroform in hundreds of cases without any bad result, and considers it safe and reliable. Another had almost adopted the same conclusion, after long experience, when alarming symptoms or a fatal issue occurred in his own practice, and shook his confidence. Still another has been alarmed by apparently dangerous phenomena resulting from ether, and has returned to chloroform, with the idea that its dangers, as compared with ether, have been exaggerated. There is this well-known peculiarity with regard to chloroform, that a patient may take it for many



times with perfect impunity, and then its administration results fatally, amid apparently the same conditions under which it was previously given.

It must, nevertheless, be admitted that, notwithstanding the objections urged against chloroform as an anæsthetic, it occupies by no means a weak, even if a debatable, ground.<sup>1</sup> A recent writer claims that, "by proper care, chloroform is a sufficiently manageable and safe agent for use," and that "it is not the chloroform which is to blame, but the mode of administration."

In Scotland it is employed almost exclusively, and the number of physicians is everywhere large who do not hesitate to give chloroform as an anæsthetic. The time has not yet come when chloroform will be laid aside, and its use will continue so long as there is the existing diversity of opinion regarding its merits. Hence it must be now, as it has been, the earnest wish of physicians to diminish the attendant dangers. The present prominent remedial measures to nullify chloroform-poisoning are: the production of artificial, to take the place of natural respiration; the lowering of the head, to supply the brain with blood and avert syncope; drawing forward the inferior maxilla, and thus opening the larynx by traction on those muscles connecting the lower jaw with the larynx and os hyoides;<sup>2</sup> brandy administered hypodermically, and faradism to arouse the nervous system. These agencies have doubtless rescued many from impending death.

The medicinal agent which seems to promise most as an antidote is the nitrite of amyl, since physiological experiments have developed an antagonism between the effects of nitrite of amyl and chloroform. While chloroform impairs reflex excitability and produces contraction of the cerebral vessels, amyl nitrite restores this excitability and causes their dilatation. Into the enlarged vessels the blood freely enters, and a rapid circulation follows.

Says Mr. C. Bader, who has had an interesting experience with this remedy: "In three or four seconds after taking three drops of nitrite of amyl on sugar, the blood-vessels of the

<sup>1</sup> *British Medical Journal*, January 1, 1876.

<sup>2</sup> Placing the patient on the left side has also been found serviceable.



retina (chiefly the veins) become enormously dilated and gorged with blood, leaving no doubt as to simultaneously existing cerebral hyperæmia, with accelerated circulation of blood.”<sup>1</sup> As to the essential mechanism of this effect, it must be regarded as not yet fully understood, but Dr. Robert Pick considers that the following conclusions are established by former and recent experience:<sup>2</sup>

1. Amyl nitrite produces a direct paralysis of the vascular wall.

2. The effect of the drug must be peripheral, but whether the smooth muscles themselves, or the terminal ends of nerves in these, or, finally, certain hypothetical peripheral ganglionic cells, are the points of attack, is unknown, and will not be so easily decided.

It is not necessary to give a detailed account, in this paper, of the preparation of nitrite of amyl, since it has been fully described by previous writers, and this article deals with but one of its many therapeutic effects. It is a volatile, greenish-yellow liquid, with a strong odor of bananas, made by the action of nitric or nitrous acid on amyl alcohol, and its chemical formula is  $C_5H_{11}NO_2$  (or  $C_{10}H_{22}ONO_2$ ). It should not be confounded with the nitrate of amyl, which has a higher specific gravity (0.919), a higher boiling-point ( $147^\circ$  to  $148^\circ$ ), possesses a disagreeable, *cimicicular* smell, and is colorless.<sup>3</sup> The nitrite is usually administered by inhalation, but it may be given hypodermically, or by the mouth. The usual dose is about five drops, inhaled from a cloth, but, with regard to this, we may refer to the following testimony of the well-known S. Weir Mitchell, who says, “I find physicians very timid as to this remedy, but, after much and long use of it, I have altogether lost the dread of it with which I began.”<sup>4</sup>

A convenient and portable vehicle for carrying this volatile medicine is the closed-glass capsule made at the suggestion of Dr. T. A. McBride, of this city, by Mr. F. Baagor, of

London *Lancet*, May 8, 1875.

<sup>2</sup> *Deutsches Archiv für klinische Medicin*, February 25, 1876, Dr. Robert Pick. See also *British Medical Journal*, February 26, 1870.

<sup>3</sup> *Chemist's and Druggist's Circular*, from *Pharm. Zeitung*.

<sup>4</sup> “Transactions of the College of Physicians of Philadelphia,” 1875.

the New York Dispensary. These capsules contain about five drops of the remedy, and the method of using them is to break them in a cloth.

Here let me add that, while this paper may, perhaps, have some scientific value, it has a practical interest chiefly for those who consider chloroform as an available anæsthetic for general use.

In a communication to the *New York Medical Gazette*, of June 11, 1870, I recommended *nitrite of amyl* in the following terms: "It would seem worthy of a trial in the threatened syncope from chloroform, since the inhalation of but a few drops is followed by marked acceleration of the heart and flushing of the face. The writer poured about eight drops upon a towel, and, as an experiment, snuffed it two or three times, when immediately the radial pulse became accelerated, the heart throbbed with much force, and the pulsation of the cranial vessels became almost painful. At the same time there was a decided tingling of the ears. The symptoms lasted but a few moments, the tingling remaining after the circulation had become quiet." This is, I believe, the first suggestion for the use of the nitrite of amyl as an antidote to the effects of chloroform, but I am not aware that it was thereupon employed with a view to avert any of the deaths from chloroform which occurred about that period.

In the "Transactions of the Fourth Annual Session of the Medical Society of Virginia, 1873," is a paper by Dr. William C. Dabney of Charlottesville, Virginia, on "Nitrite of Amyl as an Antidote to Chloroform." Dr. Dabney was not aware that any one had previously written upon the subject. He argued from Richardson, who believed that the "nitrite of amyl was, as an excitant of vascular action, the most powerful agent as yet physiologically discovered," as well as from a case of fainting, in which amyl nitrite was used with good effect, at the suggestion of Dr. J. L. Cabell, that it might prove of great value in some cases of threatened death from chloroform. To test its value, he made the following experiments:

EXPERIMENT I.—Adult cat. The administration of chloroform was begun at 2.07 o'clock. At 2.15 the cat seemed

thoroughly narcotized; the pulse was regular and strong, and breathing normal. At 2.19 the heart's beat was very weak and irregular, and the breathing very slow and labored. At 2.21 the heart's impulse was almost imperceptible; respirations gasping and at long intervals. Dropped five drops of amyl on a chip and held it to her nose; 2.23, the heart was beating stronger and more regularly; 2.25, heart beating with great force, and the breathing was hurried. She tried to move at this stage, but seemed to have lost all power over the voluntary muscles, except those which move the head from side to side, which responded slightly. At 2.30 she could move her fore-legs and body, but dragged her hind-legs. At 2.40 she had entirely recovered.

In this case the chloroform was given *gradually*, and mixed with a large proportion of atmospheric air.

EXPERIMENT II.—Adult dog (terrier). The administration of chloroform was begun at 7.23 P. M. At 7.30 the dog was howling and scuffling, and passed his feces. At 7.38 the narcosis was complete; the pulse and breathing were regular. At 7.42 the pulse was very weak. At 7.45 pulse almost imperceptible, breathing slow and labored. At 7.46 *injected* five minims of amyl hypodermically; 7.48, heart beating violently, breathing quick, animal still apparently unconscious; 7.53, could move his head from side to side, but could move no other part of his body. He was then put out-of-doors (it was winter). At 8 he seemed to have entirely recovered. The chloroform-vapor was mixed with air and given freely.

EXPERIMENT III.—Adult dog (terrier). Chloroform was given till his heart-beat was almost imperceptible, and respiration at long intervals. Injected five minims of amyl; in two minutes his heart was beating with great force, and his breathing was very quick. The chloroform was mixed with air and given slowly.

EXPERIMENT IV.—Half-grown puppy. The administration of chloroform was begun at 11.15, *and all air was excluded*. 11.18, dog was howling and trying to escape; 11.20, poured on more chloroform. At 11.23 pulse weak and breathing very labored. At 11.25 the breathing suddenly ceased;



heart beating very faintly. Stopped the chloroform and injected five minims of nitrite of amyl, and began artificial respiration, but could not arouse the animal in any way, or get the heart to act. At 11.30 I took out the heart, the right cavities of which were filled with venous blood, and dropped on it four or five minims of amyl. This produced some contraction.

In the first three experiments the chloroform-vapor was mixed with air and given slowly. In the fourth all air was excluded, and the animal was overwhelmed with a large quantity of vapor at once.

In the first three experiments, also, the heart's action was much more affected than the respiration. In the fourth the respiration had ceased entirely before the amyl was injected.

In the first three experiments the amyl produced a decided increase in the frequency and force of the heart-beats; in the fourth no effect was produced.

These experiments of Dr. Dabney seem to have attracted but little attention, nor am I aware that any effort was consequently made to diminish the mortality from chloroform by a resort to this agent.

The next important notice of this subject is from the pen of Dr. M. Schüler, in an article contained in the *Berliner Klinische Wochenschrift* of June, 1874, on the action produced by certain medicinal agents on the cerebral vessels.<sup>1</sup> His experiments were upon rabbits, which he prepared by carefully removing a small portion of the skull, and leaving the dura mater intact. He thus writes:

"Chloroform inhaled in the same manner as the nitrite of amyl produces, after from six to twelve inspirations, a commencing diminution of the arteries of the pia mater, and then of the veins. This is accompanied by a corresponding decrease in the pulsations. Soon follows an increasing relaxation of arteries and veins, and, at last, marked venous stasis. This might rather be termed a decided 'cyanosis.' As a result of

<sup>1</sup> "Ueber die Einwirkung einiger Arzneimittel auf die Gehirngefäße. Von Dr. Maximilian Schüler, in Bad Laubach bei Coblenz am Rhein, früher Assistent am physiologischen Institut zu Jena. *Berliner klin. Wochenschrift*, Nos. 25 and 26, 1874.

the venous condition of the blood, the arteries become speedily of a darker hue. After a time the pulse rises somewhat, but at last beats still more slowly as the inhalations continue. The condition of the vessels referred to undergoes no noticeable change. Not until the free admission of atmospheric air is there any variation in the calibre of the vessels or their venous hue. . . . The nitrite of amyl promptly removes the effects of chloroform on the vessels of the pia mater. The arteries dilate and speedily resume their bright color in consequence of a freer circulation. The veins also become of a clearer hue, and the respiration, which has been previously embarrassed, grows easier and more frequent." He also states that "the reflex excitability which has been destroyed by the powerful chloroform narcosis is soon fully reëstablished under the influence of the nitrite of amyl.

It will be noticed that the experiments previously cited have been practised only upon the lower animals, but in the London *Lancet* of May 8, 1875, is a narration by Mr. C. Bader, of Guy's Hospital, of several cases in which amyl nitrite was given to patients in order to avert the dangerous effects of chloroform. In the first case, chloroform was administered in combination with alcohol and ether. He cites the following :

"CASE I.—Given a mixture of alcohol, ether, and chloroform. Young man hydrocephalic, inherited syphilis; iridec-tomized on both eyes; suddenly became pale, deeply insensible, with pulse and respiration very defective. Lint, with a few (three) drops of the nitrite of amyl, was placed over nose and mouth. In two or three seconds a deep inspiration, followed by others, flushed face, quick pulse, and return of sensibility, were observed.

"CASE II.—(Given chloroform. A boy, pale, fat, blue lips and cheeks, became suddenly very faint (blue lips, blood turning black, breathing very imperfect). The same quick result, with vomiting, followed the inhalation of the nitrite of amyl (three drops).

"CASE III.—(Given chloroform. A middle-aged woman; suddenly became blue in the face, and stertorous (tongue falling back). Lint, with ten drops of the nitrite of amyl, was

placed over mouth and nose. In a few seconds the blueness and stertorous breathing gave way to good color, regular breathing, and sickness and vomiting, though no food had been given for several hours."

There is also an account of some experiments which bear upon the antagonism between nitrite of amyl and chloroform in a paper read before the Southern Michigan Medical Association, July 13, 1875, by W. N. Smart, M. D., of Hudson, Michigan.<sup>1</sup> Although these experiments were made upon the inferior animals subsequently to the time when it had apparently been shown by Mr. Bader that the nitrite of amyl would neutralize at least some of the dangers to which man is subject when under the influence of chloroform, they present features of special interest, and are worthy of study. They are here subjoined :

"EXPERIMENT I.—Gave a medium-sized cat chloroform by inhalation, *until respiration ceased* ;<sup>2</sup> time required, three and a half minutes. After waiting *thirty seconds*, I began artificial respiration, at the same time holding a cloth, on which ten drops of nitrite of amyl had been placed, close to her nostrils. In twenty seconds the heart, which before had been acting very slowly and feebly, began to beat very rapidly and more forcibly. At the end of forty seconds, she gave two or three spasmodic inspirations, after which respiration went on regularly, but quite rapidly. *The effect on the pupils was very marked*. When respiration ceased, they were fully dilated. After taking three or four inspirations of amyl, they contracted rapidly,<sup>3</sup> till a state of extreme contraction was reached. After allowing her to come out from under the influence of the chloroform enough, so that she attempted to get up, I caused her to inhale amyl for one minute, when I again gave her chloroform, having the strength of the vapor, as near as possible, the same as at the first inhalation. This time seven minutes were required before respiration was arrested by the chloroform, anæsthesia being considerably delayed.

<sup>1</sup> *Detroit Review of Medicine and Pharmacy*, November, 1875.

<sup>2</sup> Not italicized in the original article.

<sup>3</sup> This would imply coincidence of contraction of the pupil with dilatation of cerebral vessels.



"After waiting *one minute after respiration ceased*, used artificial respiration, and gave amyl as before, with about the same result.

"EXPERIMENT II.—3.35 p. m., injected fifty minims of chloroform into the peritoneal cavity of a small-sized cat, having previously ascertained that this quantity, when so used, was sufficient to cause death in about two hours, in cats of medium size. At 3.53 p. m., anaesthesia complete; pinching or pricking the feet produces no effect; *reflex action is so far abolished* that touching the conjunctiva produces no movement of the eyelid. At 3.55, commenced giving nitrite of amyl by inhalation; the first effect that was noticeable was to cause dilatation of the blood-vessels of the ear, which before had been scarcely visible. At 3.58, three minutes after commencing the use of the amyl, *reflex action is easily excited*; she closes the eye instantly, when the conjunctiva is touched; anaesthesia is now complete; the foot is jerked away when the toes are pinched; stopped giving the amyl. At 4.05 p. m., touching the conjunctiva produces no effect. Now held a vial, containing amyl, close to the nostrils for one minute, which had the effect of again restoring reflex action, and some degree of sensibility. At 4.15, can yet excite some reflex movements; anaesthesia nearly complete; heart acting rather slowly and feebly; again placed the vial of amyl near the nostrils, when the contractions of the heart became considerably more forcible, but were not much increased in number. At 4.30, anaesthesia very profound; cannot excite movements of any kind. At 4.35, respiration very slow and superficial; gave amyl for two or three minutes, when respiration became deep and regular, and anaesthesia imperfect; on pinching the toe, the foot is drawn away. At five o'clock, anaesthesia again complete, and respiration getting very feeble; gave a few drops of amyl; after breathing it for a few minutes, she showed signs of returning consciousness, and made an effort to get her nose away from the vial of amyl. On touching the conjunctiva, the eyelid is quickly closed; on pinching the toes, the foot is jerked away, and she evidently tries to get away. *Anaesthesia did not again return*, and at six o'clock she seemed perfectly recovered, with the exception of great muscular weakness.

EXPERIMENT III.—Gave a half-grown kitten a *mixed vapor* of chloroform and nitrite of amyl, containing about forty-nine parts of the former to one of the latter. I gave this by placing chloroform and amyl, in the above proportion, in a thick cloth sack, which was drawn over the head and held close around the neck, the chloroform and amyl being renewed several times, in order to insure a strong vapor. The effect produced by breathing this vapor for fifteen minutes is, a rapid though deep inspiration; a rapid and rather feeble action of the heart; an inability to coördinate movements; a *very slight degree of anæsthesia*, and a species of intoxication resembling that produced by alcohol.

“I now removed the amyl and gave the chloroform alone, in the same manner that I had been giving the mixture. The result was profound anæsthesia and complete muscular relaxation within three minutes. Then removed the chloroform and held a vial of amyl to the nostrils. In three minutes the cat was so far restored as to attempt to get up, and seemed perfectly conscious, though the power of coördination did not return for an hour.”

The different experiments quoted in this paper have been given at length, because the subject is comparatively new and the experiments differ considerably in their details. I have not had an opportunity of testing the action of this agent upon the human subject when in impending danger from chloroform, but should do so did the occasion present itself. My own recent experiments upon the inferior animals are few, yet I think they show an antagonism between nitrite of amyl and chloroform. They are as follows:

Assisted by my friends Drs. J. H. Anderson and H. D. Nicoll, a medium-sized and rather feeble cat was brought rapidly under chloroform, which was freely given,  $\frac{5}{8}$  ij having been used. When respiration ceased, ten drops of nitrite of amyl were injected hypodermically, a cloth wet with a few drops of the same was held to the nose, and artificial respiration commenced: pupils fully dilated. No reaction whatever ensued.

CASE II.—Present, Dr. J. H. Anderson. The subject was a feeble kitten, about six weeks old.

10.30 P. M., before giving chloroform, heart very active, as if from fear. Gave chloroform on a napkin, gradually and mixed with air, as to the human subject. 10.40, respiration abdominal and jerking, heart's action feeble and irregular. Reflex action, as shown by touching conjunctiva, greatly reduced. A few drops of amyl were put upon a napkin and held to the nose. 10.42, winks. 10.45, respiration regular and full, heart beating freely and regularly, muscular relaxation still complete. Reflex action restored. Putting bottle of amyl to nose, averts her head. Disposition to turn over. Resists raising the limbs. Repeated chloroform. 10.50, kitten active and resisting. 10.53, pulse irregular. Placed amyl to nostrils, no reaction, respiration wanting, kitten apparently dead. Injected ten drops of nitrite of amyl in two doses hypodermically, drew forward the tongue with a tenaculum; held a napkin, on which were a few drops of amyl, to the opened mouth, and made artificial respiration by compressing and relaxing the chest with the hand. A slight gasp soon followed. 11 P. M., heart faint but improved, reflex action restored, winks if the eye is blown upon, respiration still mainly abdominal. Muscular relaxation almost complete. 11.5, moves freely, thoracic respiration restored. 11.20, mews vigorously, walks about irregularly. 11.45, muscular coördination not yet restored.

I did not consider the kitten as requiring further notice, and left her in my office for the night. In the morning I found her rigid and dead.

CASE III.—Present, Dr. H. D. Nicoll. The subject was a small cat. Heart beating rapidly.

2.20 P. M., gave chloroform on a sponge in a small cone, with free admission of air. 2.27, full anæsthesia, respiration gasping and abdominal, about six to the minute, heart fluttering, pupils unchanged. Discontinued chloroform and held a napkin to the nose, on which were a few drops of nitrite of amyl. 2.29, artificial respiration not employed, heart stronger, regular, and very frequent; cat sits up. 2.30, walks, but with failure of muscular coördination of posterior extremities. Quantity of chloroform given about ʒij. 2.35, cat almost restored; resumed chloroform. 2.41, anæsthesia com-



plete; pupils largely dilated; reflex action abolished. 2.43, respiration suspended for half a minute, heart very feeble and fluttering. Injected five drops of nitrite of amyl hypodermically. 2.44, respiration resumed, heart stronger and more regular. 2.45, respiration regular, pupils react to light. 2.55, sits up, but unable to control posterior extremities, seemed occasionally to require rousing, and fresh air and artificial respiration were made available. 3.5 P. M., nearly well, but coördination of posterior extremities not yet restored. 4 P. M., about as well as before experiment.

The first experiment merely proves that chloroform must not be pressed too far before the employment of restoratives. In the second, an antagonism between chloroform and nitrite of amyl is shown during the first part of the experiment, and afterward an animal apparently dead was so far resuscitated as to be considered out of danger, and seemed to be moving progressively toward recovery. The third experiment corroborates the testimony of previous observers.

Dr. Rufus R. Hinton communicates the following case to the Philadelphia *Medical Times* of July 31, 1875: "Captain H. called at my office to be treated for a whitlow involving the first and second joints of the middle finger. Dreading the operation of laying open the finger with a knife, the captain suggested the use of chloroform, which he had taken for two or three minor operations while in the army, without any bad result. I sent for  $\frac{3}{4}$  of Squibb's chloroform, and, pouring two or three drachms upon his handkerchief, directed him to inhale it, at the same time directing him to elevate his hand, intending, as soon as the hand dropped, to lay open the finger. As the hand dropped I noticed that the patient was of a deathly pallor and had ceased breathing; opening his mouth and drawing his tongue forward with a tenaculum, I immediately applied five drops of the nitrite of amyl to the nose and mouth. To my delight, flushing of the face with violent beating of the carotid ensued, and the captain opened his eyes, wanted to know where he was, and consented to have his finger incised without the further use of chloroform.

We have thus followed the idea of an antagonism between

the effects of nitrite of amyl and chloroform, from the time when it was first suggested, to the demonstration of such properties by experiments upon the lower animals, and then upon man. The question arises as to what degree the dangers of chloroform are diminished by the use of the nitrite of amyl. An inference from the experiments cited would teach that, as in Dr. Dabney's fourth experiment, and my first, very "thin partitions" divide the "bounds" between chloroform anæsthesia and death, and that chloroform must still be used with great precaution. Yet I think it cannot be reasonably doubted that we have in the nitrite of amyl a decided aid against the lethal effects of chloroform. In the light of our present knowledge, it seems to me that humanity and science alike require that, when chloroform is used as an anæsthetic, the nitrite of amyl should be at hand as one of the remedies whose efficiency is to be tested in case of impending danger.







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